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(54) Seismic explosive

(57) The present invention provides an end closure for an explosives shell and an explosive package, both of which are useful for seismic explosives. The end closure comprises a rigid substantially flat plastics disk 15 connected at its periphery, with a water-tight joint, to a thin walled female screw threaded plastics tube 2, said tube being adapted to engage with an open end of an explosives shell 1. The explosive package contains a plastics component comprising a tube having a male threaded portion 3 at one end and having a capwell 13 at said end, said capwell 13 being situated coaxially within the tube, said capwell having an annular cap sensitive explosive 20 disposed about the capwell 13, along substantially the whole length of the capwell 13, said annular explosive 20 having a diameter less than the smallest diameter across the inside of said threaded portion.

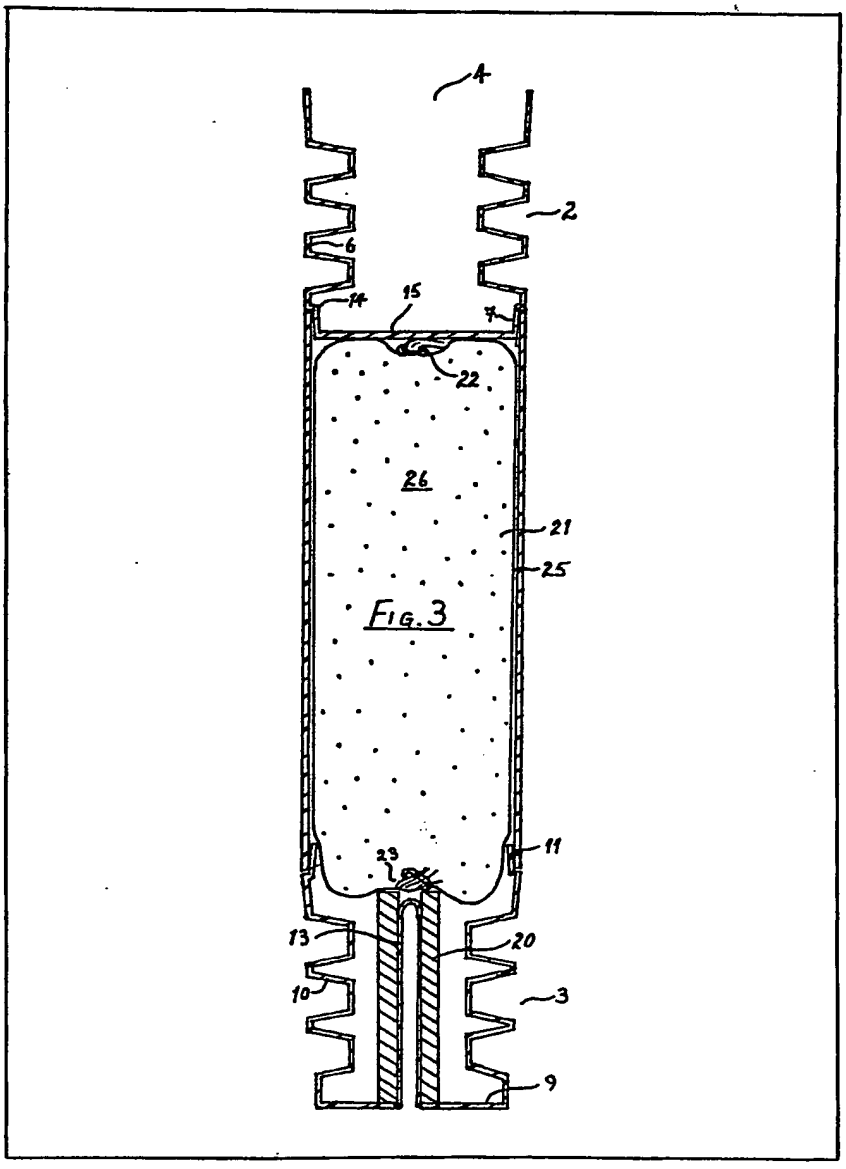

FIG. 3

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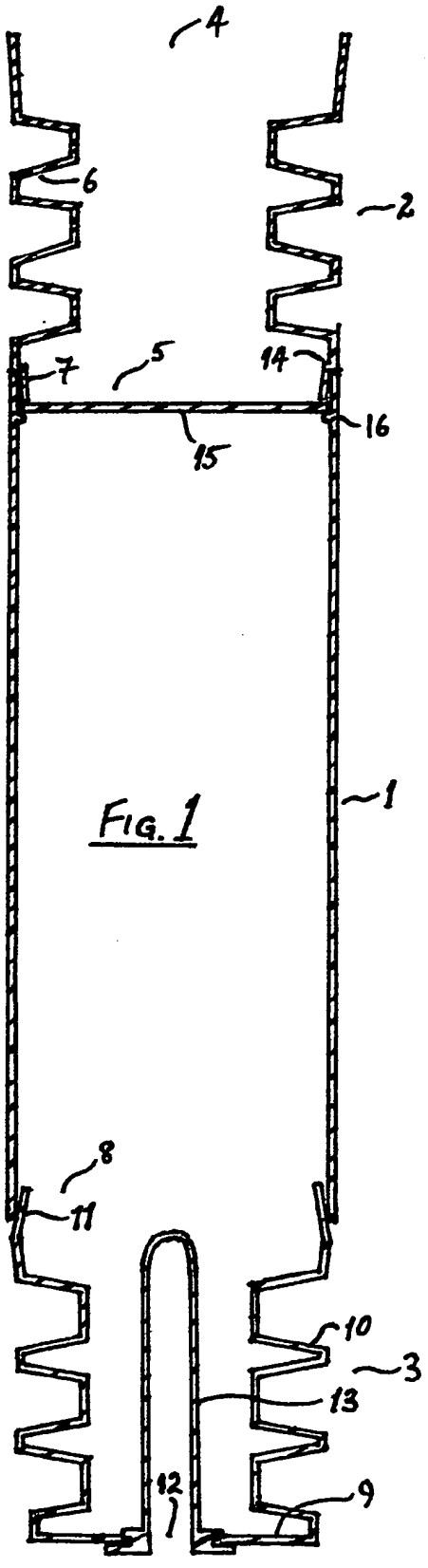
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FIG. 1

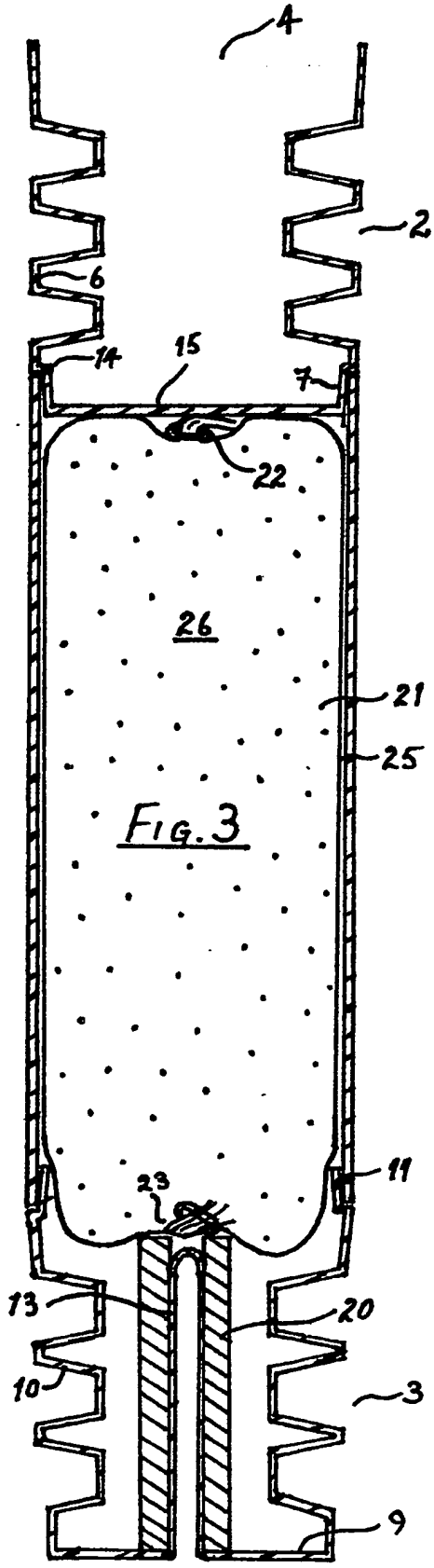
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FIG. 3

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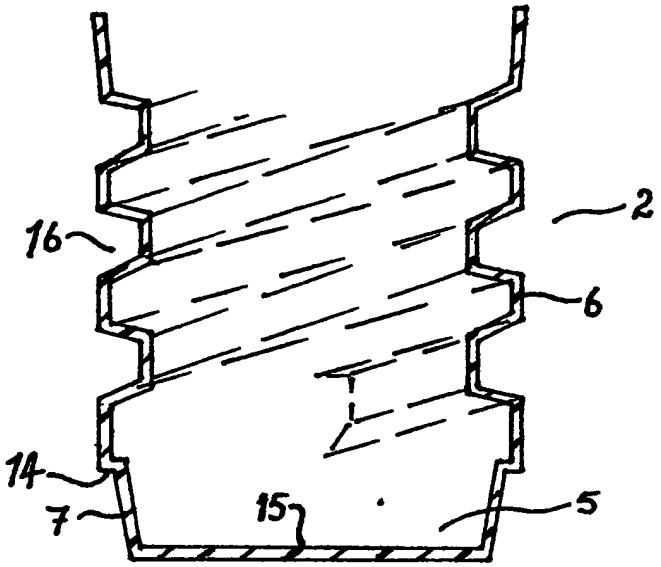

FIG. 2

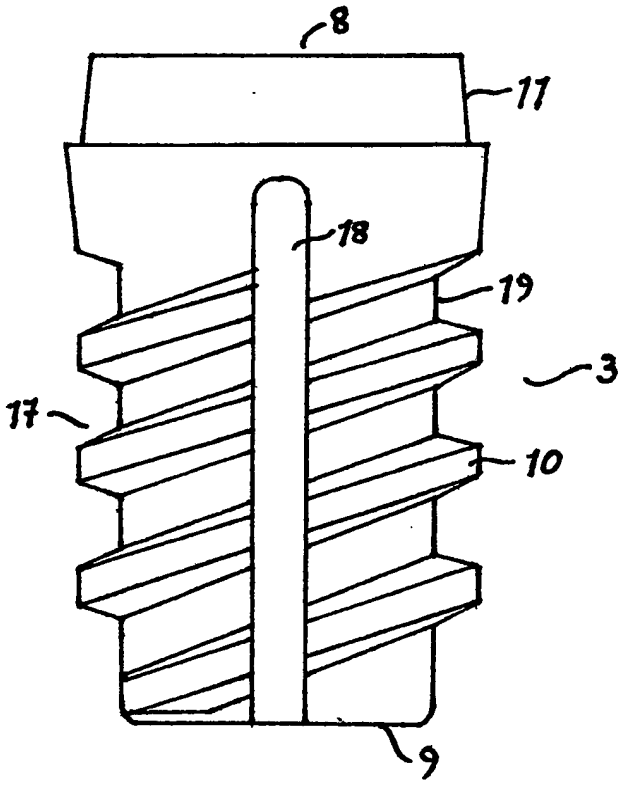

FIG. 4

SPECIFICATION
Seismic explosive

The present invention relates to an assembly of components for making an explosives container. The container, when filled with explosive, forms a package useful primarily in seismic prospecting applications. The term "plastic" as used herein means those synthetic thermoplastic and thermosetting polymers capable of being moulded.

In the seismic prospecting industry, in which explosives are detonated at the bottom of a borehole drilled within a geologic formation, it is known to use, for example, nitroglycerin-based explosives packaged in cylindrical cardboard or plastic containers. One such plastic container, disclosed in Canadian patent 730 436, of J. F. Hamilton, which issued 1966 March 22 comprises a thin-walled substantially cylindrical plastic container closed at one end, having a male thread at the closed end and a female thread at the open end. Such a container, and similar ones, are adapted to be interconnected with other like containers. The containers may be filled with explosives of various types, depending on the intended use for the explosive. For example, the container may be filled with slurry explosives or nitroglycerin-based explosives. A closure cap is placed in the open end of the container to seal the explosive within the container.

Blasting explosives packaged in containers as described above may be primed for initiation to detonation by punching a hole in the container and inserting a blasting cap into the punched hole. Alternatively the blasting explosive package may be connected to a booster device, and the booster device primed with a blasting cap. An example of such a booster device is disclosed in Canadian patent 823 428, of S. F. Foster which issued 1969 September 23.

It may be seen therefore that for some applications it is desirable to have an explosive package comprising a booster device and blasting explosive encased in the same container. Indeed such a package is envisioned by D. H. Pack et al in U.S. patent 3 504 628, which issued 1970 April 7.

Commercial booster devices generally comprise a highly brisant explosive e.g. trinitrotoluene (TNT), cyclonite (RDX), Composition B (a mixture of TNT and RDX) or pentolite (a mixture of TNT and pentaerythritoltetranitrate). Teh explosive, which may be cast or pressed, is encased in a tubular container having suitably positioned orifices adapted to receive a blasting cap e.g. a capwell, or detonating cord e.g. a through-tunnel.

Most known techniques for casting or pressing explosives to form a booster having a capwell involve inserting a thimble, tube or removable core longitudinally into the confines of a tubular casing. Explosive is then cast or pressed into the tubular casing to surround the thimble, tube or core, while leaving an open end of the thimble, tube or core at one end of the booster, to form the capwell. Examples of such techniques may be found in the disclosures of G. L. Griffith in Canadian patent 973 756 which issued 1975 September 2.

In seismic prospecting it is common to couple several explosives packages together to form a column. Only one of the packages, usually one at or near the bottom of the column, has a blasting cap inserted into the primer-end of the package. The remaining packages in the column do not have blasting caps therein. Initiation to detonation of the column occurs as follows: the blasting cap initiates the primer of the one package, which in turn initiates the main charge in the same package and in the package below; detonation of the main charge of the first package then causes intiation of the primer in the next-coupled package which in turn initiates the main charge in the same package; and so on, along the column of packages. A typical example of such a package is disclosed in U.S. Patent 4 294 171, of G. H. Ducharme which issued 1981 October 13.

In one commercially available embodiment of the package of Ducharme, a 76 mm by 12.7 mm outside diameter piece of Detaprime* flexible tubular explosive is situated around the closed end of the capwell. The capwell and Detaprime explosive are encapsulated in a block of cast TNT to form a primer. A disadvantage of such a package is that the primer may be difficult to be initiated to detonation, by detonation of a main charge in an adjacent package. As a result the detonation of the explosive column may not be as effective as desired.

Another disadvantage of the prior art explosives packages which make use of blow-moulded or injection-moulded plastic containers is that moulds must be prepared for the various sizes of explosive i.e. there must be separate moulds for 0.5 kg and 1.0 kg explosives packages even if the containers for such packages are of the same diameter. Such moulds are expensive. In addition, if threads are used as the interconnecting means for adjacent containers, the threads must be shallow when the main charge is also encased in a chub cartridge of the type disclosed in U.S. patent 4 294 171. If the threads are deep, the chub cartridge, which has diameter slightly less than the internal diameter of the plastic container, cannot be inserted into the container through the threaded female end of the container. Use of chub cartridges is desirable both from the standpoint of enhanced water resistance for the explosives package and from the standpoint of ease of manufacture.

A container which overcomes many of the above disadvantages has now been found.

Accordingly the present invention provides a container in the form of a kit of parts, said kit comprising:

a) a first component comprising a cylindrical tube;

b) a second, plastic, component comprising a short tube open at both ends, one end of the

* denotes trade mark.

second component being adapted to engage with one end of the first component and the other end of the second component being adapted to receive and engage with a third component of a like assembly;

c) a third, plastic, component comprising a short tube having an open end and an essentially closed end, the open end of the tube being adapted to engage with the end of the first component which is not engaged with the second component, and the substantially closed end of the third component being adapted to receive and engage a capwell such that, when engaged, the capwell is situated substantially longitudinally inside the third component, said third component also being adapted to engage with the second component of a like container;

d) a closure disk adapted to be secured to said first or second component at the conjunction of the first and second components when said first and second components are engaged, said first or second component being adapted to permit the closure disk to be secured thereto; and

e) capwell adapted to engage with and be secured to the third component.

In one embodiment of the present invention the first component has two parallel circumferential ridges disposed on the inner side of thereof about a plane which is perpendicular to the longitudinal axis of the first component, and the closure disk is adapted to be snap-fitted between the ridges.

In another embodiment the closure disk is made of the same plastic material as the first component, has the same diameter as the internal diameter of the first component and is adapted to be bonded thermally or with a water-proof adhesive to the first component.

In a further embodiment the closure disk is a rigid flat disk integrally moulded with the second component such that the second component has an open end and a closed end, said closed end being adapted to engage with one end of the first component.

In a preferred embodiment the second and third components are each adapted to slip inside the first component sufficiently far to permit the third component to engage with a second component of a like container such that the closure disk of the like container is in contact with the third component.

In a further embodiment the third component has a male thread thereon and the second component has a corresponding female thread therein; preferably the threads have deep grooves therebetween.

In yet another embodiment the third component has at least one longitudinal furrow passing through the male threads, said furrow being adapted to permit a detonating cord or leg wires of a blasting cap to lie therein.

In another embodiment the capwell is integral with the third component.

In a further embodiment the components are made from a heat sealable synthetic thermoplastic polymer e.g. polyethylene.

In yet a further embodiment the container contains an explosive and the first component is spin welded to both the second and the third components, and to the closure disk if it is not integral with the second component.

The invention also provides an explosive package comprising a container, a booster and a main charge, said container comprising a first component comprising a cylindrical tube; a second, plastic, component comprising a short tube open at both ends, one end of the second component being positively engaged within one end of the first component and the other end of said short tube being adapted to receive and engage a third component of a like package; a third, plastic, component comprising a short tube having an open end and an essentially closed end, the open end of the short turbe of the third component being positively engaged within the other end of the first component, said short tube of the third component being adapted to fit inside and engage with the second component of a like package, said third component having a capwell situated substantially longitudinally inside the third component and extending from the closed end thereof; said booster comprising a cap-sensitive explosive situated annularly around the capwell inside the third component, said booster being sufficiently sensitive to be initiated to detonation by detonation of a main charge of a like package engaged with the third component, and being of sufficient explosive strength to initiate an undetonated main charge, said main charge being an explosive substantially filling the inside of at least the first component and in contact with said booster, said main charge being sufficiently sensitive to be initiated to detonation by detonation of the booster and being of sufficient explosive strength to initiate an undetonated booster in the third component of an adjacently coupled like package; the distance between the booster and the closed end of the third component being no greater than about 7mm, said main charge being held in the first component by a closure disk secured to the first or second component adjacent the conjunction of the first and the second component.

Preferably the distance between the booster and the closed end of the third component is from 0 to 4 mm.

In a preferred embodiment the main charge is a water gel or emulsion explosive in a chub cartridge.

As used herein the term "chub cartridge" refers to an explosive packaged in a tube made from a film, said tube having each end gathered and secured e.g. by a metal clip. One such chub cartridge is disclosed in Canadian patent 1 003 693, of R. S. Arnew which issued 1977 January 18.

It has been disclosed herein that the closure disk may be integrally moulded with the second component. When integrally moulded, the second component and closure disk form a female end closure coupling which may be used in

conjunction with the first component of the present invention or with other explosives shells having an open end. Such a female end closure coupling is preferred because it prevents dislodgement of the closure link. Dislodgement of the closure disks of containers of the prior art is a common occurrence in situations where a column of packages is pushed into a borehole with a loading pole.

The term "explosives shell" or "shell" as used herein refers to a tubular container which has at least one end open.

Accordingly the present invention also provides an end closure for an explosives shell, said end closure comprising a rigid substantially flat plastic disk connected at its periphery, with a water-tight joint, to a thin-walled female screw-threaded plastic tube, said tube being adapted to engage with an open end of the explosives shell.

In a preferred embodiment the tube has a shoulder on its exterior adapted to seat the end closure upon the open end of the explosives shell.

In another embodiment the tube has a frusto-conical portion between the female thread and the disk, the frusto-conical portion being adapted to seat the end closure within the open end of an explosives shell.

The invention is illustrated by reference to the drawings in which:

Fig. 1 is a cross-sectional representation of a container comprised of the assembly of the present invention,

Fig. 2, which is shown between Figs. 3 and 4, is a cross-sectional representation of a female end closure coupling of the present invention, and

Fig. 3 is a cross-sectional representation of an explosive package of the present invention,

Fig. 4 is a side view of a third component of the present invention.

Referring to Fig. 1 the first component is shown as cylindrical tube 1.

Second component 2 comprises a tube having open ends 4 and 5. Second component 2 is narrowed at the portion 7 juxtaposed to end 5, in order to allow portion 7 to slip inside tube 1. Portion 7 may merely be tapered or may have a shoulder 14 to allow portion 7 to fit snugly within one end of tube 1. Second component 2 has female threads 6 therein. Female threads 6 may be coarse or fine i.e. have deep or shallow grooves between the threads.

Third component 3 comprises a tube having an open end 8 and a closed end 9. Third component 3 has male threads 10 thereon which are adapted to engage with female threads 6 of a second component of a like container. Closed end 9 may have a hole 12 therein in which may be engagingly inserted a capwell thimble 13. Open end 8 has a tapered rim portion 11 adapted to slip into tube 1. Rim portion 11 is similar to portion 7 of second component 2 and may merely be tapered as shown or have a shoulder (not shown) akin to shoulder 14.

Closure disk 15 may be held in place on tube 1 by spin-bonding or using an adhesive.

Alternatively closure disk 15 may be moulded integrally with tube 1, or may be mechanically held in place by its periphery resting on circumferential bead 16 on the inside of tube 1 and being trapped in position by the rim of portion 7 of the second component. Preferably however closure disk 15 is integral with second component 2 as shown in Figs. 2 and 3.

Referring now to Fig. 3, first, second and third components are arranged as in Fig. 1 and secured by, for example, spin-bonding. Closure disk 15 is integrally moulded with second component 2. A booster 20 is situated around the closed end of capwell 13 and extends substantially from closed end 9 of the third component to the closed end of capwell 13. A chub cartridge 21, which comprises e.g. an water gel explosive 26 packaged in tubular film 25, secured at both ends by clips 22 and 23, is contained within first component 1. The length of chub cartridge 21 is selected so that when second component 2 is fitted into and secured to first component 1, the chub cartridge is squashed between closure disk 15 and booster 20. This ensures that chub package 21 and booster 20 are in intimate contact. Capwell 13 is long enough to accommodate a blasting cap without the joint of the blasting cap and its leg wires protruding outside the capwell. Preferably the length of the third component is about the same length as the capwell.

Referring to the female end closure coupling of Fig. 2, the second component comprises closure disk 15 connected all around its periphery with second component 2 at end 5. Portion 7 is frusto-conical in shape having a taper e.g. of about 4 degrees. The end of portion 7 having the greater diameter is attached to female thread portion 16, there being a shoulder 14 which may abut an end of tube 1. (Fig. 1) The second component has deep female threads 6 having a pitch of for example about 1.33 threads per turn.

Referring to Fig. 4 the embodiment of the third component, 3, shown comprises a threaded tube, closed at end 9, apart from capwell hole 12 (not shown). Third component 3 is open at end 8. The rim portion 11 of component 3 adjacent open end 8 is frusto-conical. Attached to the frusto-conical portion 11 is threaded portion 17 having male threads 10. Male threads 10 are adapted to mate with female threads 6 of the second component. Male thread 10 is interrupted with a longitudinal furrow 18, which is deeper than the depth of the grooves 19 between turns of male thread 10. The depth and width of furrow 18 is sufficient to permit a strand of detonating cord or blasting cap legwires to lay therein. The end of furrow 18 adjacent to frusto-conical portion 11 is adapted to permit detonating cord to extend therefrom when the male and female threads are screwed together tightly.

Assembly of the explosives package may be carried out by first attaching a booster 20 to a capwell thimble 13. The capwell 13 is then inserted into the hole 12 in the closed end 9 of the

third component. Capwell thimble 13 may be "snap-fitted" into hole 12 or may be otherwise securely engaged to the closed end 9 of the third component e.g by spin-bonding.

Alternatively the capwell, if separate from the remainder of the third component, may be "snap-fitted" or spin-bonded to the third component and the booster then attached to the capwell. The first component 1 is secured e.g. spin bonded to the third component 3 to form a long tube with a closed male e.g. threaded end. A chub cartridge 21 of water gel or emulsion explosive is inserted into the first component so that the chub cartridge abuts booster 20 and the second component 2 with integrally moulded end closure 15 is slipped into the open end of the first component. The first and second components are secured by, for example spin bonding. A particularly suitable booster is an extruded tube of pentaerytheritoltetranitrate (PETN) in a plasticizer, available under the trade marks Detaprime or Detaflex.

Alternatively, another cap sensitive explosive may be placed inside the third component. The main charge which may be cap sensitive or at least is sensitive to detonation of the explosive or booster inside the third component, is placed inside the first component. For some applications the cap sensitive explosive and the main charge may be the same explosive e.g. water gel explosive extruded into the first and third components. The closure disk serves to prevent the main charge from being removed from the shell, which comprises the first and third components. The second component serves as part of a means for coupling like containers, so that a long column of explosive packages may be formed.

An advantage of the present container is that a variety of lengths of the first component may be stocked, while requiring only standard second and third components.

It is preferred that the second and third components have female and male threads thereon, respectively, which threads easily engage e.g. so-called buttress threads. Typically, one to two turns of the thread are sufficient to couple adjacent packages. Positive locking of the threads, after screwing together, may also be provided.

Positive engagement between the first and second, and first and third components may be accomplished in a number of mechanically equivalent ways e.g. gluing, spin bonding, spot welding, snap-fittings, threads. Heat sealing by spin bonding, for example, is convenient for synthetic thermoplastic polymers e.g. polyethylene, polypropylene, blends of polyethylene with ethylene-vinyl acetate copolymers. Spin-bonding is known in the art of joining synthetic thermoplastic polymers and comprises spinning one part relative to a second part while keeping the two parts in frictional engagement. The friction is sufficient to melt contacting portions of the first and second parts. Upon stopping spinning the molten portions fuse together to form a strong essentially water proof joint.

It will be understood that the capwell may be moulded integrally with the third component if desired.

It is preferred that the third component has a longitudinal furrow on the outside of the tube e.g. interrupting the threads, so that legwires from a blasting cap inserted in the capwell will not be damaged when two like containers are engaged e.g. threaded together.

The present invention may be further illustrated by reference to the following.

The first component preferably is made from high density polyethylene extruded in tubular form, and having an appropriate length. It may be produced by extruding the polyethylene in tubular form by methods known in the art. The thickness of the tube must be sufficient to give the assembled container rigidity and is generally between 1.0 and 2.5 mm. A thickness between 1.3 and 1.7 mm is especially preferred.

As stated hereinbefore the second component preferably is combined with the closure disk to form a female end closure coupling. Such a coupling is preferably blow-moulded from high density polyethylene. The closure disk portion preferably is a flat disk, joined at all segments of its periphery with the tubular portion of the female end closure coupling. The disk may be, for example, from 1 to 2 mm thickness. The frusto-conical portion of the second component, adjacent to the closure disk, preferably is tapered at from about 2° to 10°, especially from about 3° to 5°. Attached to the frusto-conical portion is a tubular portion having female threads therein. Preferably the threads have deep grooves therebetween to provide positive engagement of the male thread of the third component, especially at low temperatures e.g. at —20°C and below. The depth of the grooves is preferably between about 4.5 and 8 mm. The threads may be interrupted as is known in the art. The threaded portion and the frusto-conical portion preferably are joined such that a shoulder, adapted to seat on the end of the first component, is present. The shoulder is preferably from about 0.5 to about 2.5 mm especially from 1.0 to 2.0 mm in depth.

A preferred embodiment of the third component is shown in Fig. 4 and has male threads corresponding to the female threads of the second component. The third component is preferably blow moulded if the capwell is separate therefrom or is injection moulded if the capwell is integral therewith. The capwell, if separate, is preferably injection moulded in order to control its wall thickness. A suitable capwell is disclosed in U.S. patent 4 294 191.

When the grooves between the threads of the second and third components are sufficiently deep, for example from about 4 mm to 6 mm deep for a nominally 56 mm diameter container, the male and female threads couple easily, even at low temperatures e.g. below about —20°C. Such easily screwed threads permit columns of

packages to be coupled quickly and easily even at such low temperatures.

In use, a first package of the invention is taken and a blasting cap inserted into the capwell. The detonating cord or leg wires attached to the blasting cap are laid in the longitudinal furrow in the third component and taped to the outside of the first component. A like package is screwed onto the male end of the first package, thus preventing the blasting cap in the first package from becoming dislodged. A similar package is screwed onto the female end of the first package; other packages may be attached to form a column of explosives packages. The detonating cord or legwires may be taped to the upper portions of the column.

The coupled column may be borehole centering devices coupled to the ends thereof e.g. a drivepoint device as disclosed in Canadian Patent 827 427 of Graham and Rintoul, which issued 1969 November 18 to Graham and Rintoul. The coupled column is then lowered down a borehole and may be pushed with a loading pole with little risk that the loading pole will dislodge or puncture the closure disk.

The packages are screwed together so that the closed end of the third component abuts the closure disk. This permits transmittal of sufficient energy of a detonated donor main charge or booster to initiate to detonation an adjacent acceptor booster or main charge.

It is preferable that the booster be tubular and made from a slightly deformable material e.g. PETN in a plasticized matrix. The booster may then be pushed over the capwell and be in intimate contact therewith. Use of a tubular booster will necessarily leave an air gap between the booster and the internal wall of the threaded portion of the third component. It appears that the presence of the air gap does not hamper the explosive performance of the explosive package. Furthermore, provided that the booster has a thickness greater that its critical detonation diameter, it is not necessary to fill the gap between the booster and the internal wall of the threaded portion of the third component with a dense inert or explosive material e.g. sand, resin, water gel explosive.

Claims

1. An end closure, for an explosives shell, comprising a rigid substantially flat plastic disk connected at its periphery, with a water-tight joint, to a thin-walled female screw threaded plastic tube, said tube being adapted to engage with an open end of the explosives shell.

2. An end closure according to Claim 2 wherein the tube has a shoulder on its exterior adapted to seat the end closure upon an open end of the explosives shell.

3. An end closure according to Claims 2 or 3 wherein the tube has a frusto-conical portion between the female thread and the disk, the frusto-conical portion being adapted to seat the end closure within the open end of the explosives shell.

4. An explosive package containing a plastic component comprising a tube having a male threaded portion at one end and having a capwell at said end, said capwell being situated coaxially within the tube, said capwell having an annular cap sensitive explosive disposed about the capwell, along substantially the whole length of the capwell, said annular explosive having a diameter less than the smallest diameter across the inside of said threaded portion.

5. An explosive package according to Claim 4 wherein the cap sensitive explosive is PETN in a plasticized matrix.

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